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Fiber-Reinforced Sheet and Manufacturing Method Thereof

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(54) [Title of the Invention]

**Fiber-Reinforced Sheet and Manufacturing
Method Thereof**

(57) [Summary]

[Object] To provide a fiber-reinforced polyester elastomer sheet that is inexpensive and possesses excellent thickness precision, mechanical properties, and heat resistance.

[Means of Achievement] A fiber-reinforced sheet, wherein at least one side of a woven fabric composed of drawn polyester yarn is covered with a polyester elastomer sheet formed by means

of calendering, and wherein the peel strength between the sheet and the woven fabric, as determined by the test method of JIS K 6328, is 1.5 kg/cm or greater.

[Claims]

[Claim 1] A fiber-reinforced sheet, characterized in that at least one side of a woven fabric composed of drawn polyester yarn is covered with a polyester elastomer sheet formed by means of calendering, and the peel strength between the sheet and the woven fabric, as determined by the test method of JIS K 6328, is 1.5 kg/cm or greater.

[Claim 2] A fiber-reinforced sheet as described in Claim 1, in which the polyester elastomer is a polyester block copolymer in which a high-melting crystalline polymer segment and a low-melting polymer segment composed of aliphatic polyether units and/or aliphatic polyester units constitute the principal components.

[Claim 3] A fiber-reinforced sheet as described in Claim 2, in which the quantity of the low-melting polymer segment copolymer in the polyester block copolymer is 10 to 90 wt%.

[Claim 4] A fiber-reinforced sheet as described in Claim 2, in which the melting point of the polyester block copolymer is 140°C to 215°C.

[Claim 5] A sheet as described in Claim 1, in which the polyester elastomer is a polyester elastomer composition that comprises 100 parts by weight of a polyester block copolymer in which a high-melting crystalline polymer segment and a low-melting polymer segment composed of aliphatic polyether units and/or aliphatic polyester units constitute the principal components, and also comprises 0.001 to 10 parts by weight of polyolefin wax.

[Claim 6] A fiber-reinforced sheet as described in Claim 1 or 5, in which the thickness of the entire fiber-reinforced sheet is 20 to 5000 μm .

[Claim 7] A fiber-reinforced polyester elastomer sheet as described in Claim 1 or 5, used as a primary fabric for flexible containers.

[Claim 8] A method for the manufacture of a fiber-reinforced sheet, characterized in that a woven fabric comprising a drawn polyester yarn and a polyester elastomer sheet are laminated by means of calendering and are then compression bonded between rolls, by which means the peel strength of the polyester elastomer sheet and the woven fabric is brought to 1.5 kg/cm or greater, as measured by the test method stipulated in JISK 6328.

[Claim 9] A method for the manufacture of sheets as described in Claim 8, in which the temperature of calendering and roll compression bonding is 200°C or less.

[Detailed Description of the Invention]

[0001]

[Technological Field of the Invention] The present invention relates to a fiber-reinforced sheet, and, in greater detail, it relates to a fiber-reinforced sheet of superior strength and peel strength that is obtained by means of covering woven fabric composed of drawn polyester yarn with a polyester elastomer made into a sheet as a result of calendering, and to a manufacturing method thereof.

[0002]

[Prior Art] Sheets obtained by means of laminating flexible sheets on woven fabric composed of polyesters, polyamides, and polyolefins are widely used as industrial materials for construction projects and for packaging and food products, and, in particular, are widely used as primary fabrics for large products such as flexible containers and tents for industrial use. Olefin resins such as soft polyvinyl chloride resins and ethylene vinyl acetate resins are frequently used as the resin films that constitute these laminated sheets because the materials themselves are inexpensive, can be rapidly molded in large volumes, and can be manufactured at a low cost. However, the materials that are frequently used for these resin films have inadequate resistance to the transfer of compounded chemicals, possess inferior low-temperature mechanical properties, heat resistance, and oil resistance, and have a limited range of applications. In order to solve these problems, attempts have been made in recent years to use polyester elastomers that have high resistance to the transfer of chemicals into the materials of the resin film, and that possess excellent low-temperature mechanical properties and heat resistance as resin films. The method that is generally used to manufacture these laminated polyester sheets is to extrude a polyester elastomer with a T-die, to perform extrusion and lamination in which the sheets are directly laminated to woven fabric, and to perform coextrusion and lamination in which the woven fabric and the polyester elastomer are extruded at the same time. An example of coextrusion is presented in JP (Kokoku) 60-50137.

[0003]

[Problems to Be Solved by the Invention] However, when polyester elastomer sheets or laminated sheets obtained by means of covering woven fabric with these sheets are manufactured with the help of the extrusion method, and, in particular, when the sheets are extrusion molded at high speed or when the sheets contain colorants, the resin film undergo marked degradation and it is difficult to obtain the anticipated thickness precision, surface external appearance, mechanical properties, or thermal aging resistance, and, in actual practice, extrusion molding can be performed only at speeds that are lower than those for polyvinyl chloride resins and olefin resins (which are frequently used in the aforementioned applications), and the use of compounding agents such as colorants is limited to a considerable extent. As a result, manufacturing costs are high, the sheets are unsatisfactory for use as materials for the applications described above, and these sheets have yet to be put into practical use on an industrial scale.

[0004] In short, when polyester elastomers are molded with the help of the extrusion method, there is a limit on the discharge speed because melt fractures occur at the nozzle. When extrusion is performed at speeds that exceed this limit, sheets that are lacking in smoothness result, and sheets of stable thickness and mechanical properties cannot be obtained. To increase this limit on discharge speed, low viscosity polyester elastomers have been used. When the processing temperature is increased and the viscosity is lowered, there is marked thermal degradation, and this tendency increases as the polyester elastomer becomes more flexible. Moreover, this phenomenon occurs to a marked extent when the elastomer contains degradation-inducing pigments such as steel¹ phthalocyanine and flame retarders such as antimony oxide compounds, yielding sheets of unsatisfactory physical properties that cannot stand up to practical use even when thermal stabilizers are added in large quantities.

[0005] As the result, when an attempt is made to use extrusion in the manufacture of polyester elastomer sheets and woven fabric reinforced sheets in which these elastomer sheets form resin films for the applications described above, low productivity results and only sheets of unsatisfactory physical properties due to resin degradation can be obtained.

¹ Translator's note: Possible misprint for "copper"; the characters have similar appearance in Japanese and are relatively easy to confuse.

[0006]

[Means Used to Solve the Above-Mentioned Problems] The inventors found that the cause of the problems involved in the techniques in which extrusion is used to manufacture fiber-reinforced sheets in which the surface of a polyester woven fabric is coated with a polyester elastomer was that polyester elastomers have higher melting points than other resins, and hence have higher heat resistance temperatures, but that these elastomers cannot be regarded as having adequate heat resistance when they are melted at temperatures above their melting points, and, further, because the polyester elastomers have high melting points, they also have high processing temperatures, so covering woven fabric with a molten polyester elastomer brings about a reduction in the degree of drawing and orientation in the fibers of the polyester fabric thus covered. The inventors conducted intensive studies of methods for solving these problems, and, as a result, they arrived at this invention by discovering that when a polyester elastomer is made into a film by means of calendering and the surface of a polyester woven fabric is continuously covered with the elastomer with the help of compression bonding, the heat history of the polymer is greatly decreased in comparison with that observed in the case of the extrusion method, and the contact temperature of the polymer with the woven fabric is also reduced, whereby the cause of the problem described above can be solved and great improvements can be achieved both in terms of processing speed and in terms of thickness precision.

[0007] Specifically, this invention resides in a fiber-reinforced sheet characterized in that at least one side of a woven fabric composed of drawn polyester yarn is covered with a polyester elastomer sheet formed by means of calendering, and the peel strength between the sheet and the woven fabric, as determined by the test method of JIS K 6328, is 1.5 kg/cm or greater, and also resides in a method for the manufacture of a fiber-reinforced sheet characterized in that a woven fabric composed of a drawn polyester yarn and a polyester elastomer sheet are laminated by means of calendering and are then compression bonded between rolls, by which means the peel strength of the polyester elastomer sheet and the woven fabric is brought to 1.5 kg/cm or greater, as measured by the test method stipulated in JISK 6328.

[0008] There are no particular limitations on the polyester elastomer that is used in this invention. However, it is preferable that it be a polyester block copolymer of which the principal structural components are (A) primarily a high-melting crystalline polymer segment and (B) a low-melting polymer segment primarily comprising aliphatic polyether units and/or aliphatic

polyester units. The high-melting crystalline polymer segment (A) of the polyester block copolymer is a polyester comprising (a) dicarboxylic acids and ester forming derivatives thereof, and (b) diols and ester forming derivatives thereof. The dicarboxylic acids (a) that can be used include aromatic dicarboxylic acids such as terephthalic acid, isophthalic acid, phthalic acid, naphthalene-2,6-dicarboxylic acid, naphthalene-2,7-dicarboxylic acid, anthracene dicarboxylic acid, diphenyl-4,4'-dicarboxylic acid, diphenoxyethane dicarboxylic acid, 4,4'-diphenyl ether dicarboxylic acid, 5-sulfoisophthalic acid, and 3-sulfoisophthalic acid; alicyclic dicarboxylic acids such as 1,4-cyclohexane dicarboxylic acid, cyclohexane dicarboxylic acid, and 4,4'-dicyclohexyl dicarboxylic acid; and aliphatic dicarboxylic acids such as adipic acid, succinic acid, oxalic acid, sebacic acid, and dodecanedioic acid. Of course, ester-forming derivatives of dicarboxylic acids such as, for example, lower alkyl esters, allyl esters, carbonic acid esters, and acid halides can also be used.

The diols (b) that can be used are diols of molecular weights of 400 or less, for example, aliphatic diols such as 1,4-butanediol, ethylene glycol, trimethylene glycol, pentamethylene glycol, hexamethylene glycol, neopentyl glycol, and decamethylene glycol; alicyclic diols such as 1,1-cyclohexane dimethanol, 1,4-dicyclohexane dimethanol, and tricyclodecane dimethanol; and aromatic diols such as xylylene glycol, bis(p-hydroxy)diphenyl, bis(p-hydroxyphenyl)propane, 2,2-bis[4-(2-hydroxyethoxy)phenyl]propane, bis[4-(2-hydroxy)phenyl]sulfone, 1,1-bis[4-(2-hydroxyethoxy)phenyl]cyclohexane, 4,4'-dihydroxy-p-terphenyl, and 4,4'-dihydroxy-p-quarter-phenyl. These diols may also be used in the form of ester-forming derivatives such as, for example, acetyls and alkali metal salts.

[0009] These dicarboxylic acids and derivatives or diol components thereof may also be used in combinations of two or more. The most preferable example of segment (A) is polybutylene terephthalate derived from terephthalic acid and/or dimethyl terephthalate and 1,4-butanediol.

[0010] The low-melting polymer segment (B) of the polyester block copolymer that is used in this invention is an aliphatic polyether and/or aliphatic polyester. The aliphatic polyethers can include poly(ethylene oxide) glycol, poly(propylene oxide) glycol, poly(tetramethylene oxide) glycol, poly(hexamethylene oxide) glycol, copolymers of ethylene oxide and propylene oxide, ethylene addition oxide polymers of poly(propylene oxide) glycol, and copolymers of ethylene oxide and tetrahydrofuran. Further, the aliphatic polyesters can include poly(ϵ -caprolactam), polyenantholactone, polycaprylrolactone, and polybutylene adipate. Of these aliphatic polyethers

and/or aliphatic polyesters, poly(tetramethylene oxide) glycol, ethylene oxide additives of poly(propylene oxide)glycol, poly(ϵ -caprolactam), and polybutylene adipate are preferable in terms of the elastic properties of the polyester block copolymers that are obtained. The copolymerization quantity of the low-melting polymer segment (B) of the polyester block copolymers that are used in this invention must be contained within the range of 10 to 90 wt%, and, preferably, of 15 to 75 wt%. When the content is 10 wt% or less, flexibility and rubber elasticity are insufficient, and, when the content exceeds 90 wt%, crystallinity is reduced and moldability is adversely affected.

[0011] Further, known antioxidants such as hindered phenols, phosphites, thioethers, and amines may be added to these polyester elastomers in order to minimize thermal degradation during processing and to confer thermal aging resistance on the products. In addition, the following additives may be added to the elastomers in advance as desired within ranges that do not impair the objectives: mold release agents such as polyethylene wax, silicone oil, stearic acid metal salts, montanic acid metal salts, and montanic acid ester wax; weatherproofing agents such as benzophenones, benzotriazoles, and hindered amines; thickeners such as epoxy compounds and isocyanate compounds; colorants such as fluoropolymers, dyes, and pigments; UV absorbers such as carbon black; reinforcing agents such as glass fibers, carbon fibers, and potassium titanate fibers; fillers such as silica, clay, calcium carbonate, calcium sulfate, and glass beads; nucleation agents such as talc; adhesive agents; adhesive aids; flame retarders; plasticizers; foaming agents; fluorescence agents; fungistatic and fungicidal agents; crosslinking agents; and surfactants.

[0012] The woven fabrics comprising drawn polyester yarn that are used in this invention are generally commercially available products that are used in unaltered form. The denier of the drawn yarn and the number of shots in the woof and warp directions should be selected in accordance with the strength requirement. Two sheets of woven fabric can be used when needed. They can first be affixed to a calender-molded resin film, and the resin film can be used in this invention while sandwiched between the two sheets of woven fabric.

[0013] There are no particular limitations on the fiber material of the nonwoven fabric as long as it is a polyester. It may be polyethylene terephthalate, polybutylene terephthalate, a polycarbonate, or the same polyester block copolymer as the resin film. However, polyethylene terephthalate is preferable. The calendering method that is used in this invention may be a

generally known method in which the resin is held in the space between high temperature calender rolls; plasticization, foaming, and kneading are performed; and the product is calendered to a specified thickness in the space between the rolls. The formation of the rolls may be four or five reverse L-shaped, L-shaped, or inclined Z-shaped. However, a formation in which the processing time is shortened as much as possible is preferable. The processing temperature should be close to the melting point of the polyester elastomer, and should preferably be a temperature from 20°C below the melting point to 20°C above the melting point. A temperature of 200°C or less is most preferable from the standpoint of preventing degradation due to heat history. The calender molding process usually comprises several rolling stages, including plasticization, coarse molding, calendering, and cooling. A Banbury mixer, a kneader, or an extruding machine can be used in the plasticization process of the polymer within a range that does not impair the objectives.

[0014] For the method whereby a polyester elastomer that has been molded into a sheet by means of calendering is coated onto a woven fabric comprising a polyester drawn yarn, it is economically advantageous to employ a composite calendering technique in which a compression bonding roll is installed in the calendering process, the polyester elastomer is molded into a sheet, and the resulting sheet is continuously compression bonded to the woven fabric by means of using the heat already contained in the sheet. Examples include a friction method in which a difference in rotation is applied to the center roll and bottom roll of four reverse L-shaped rolls, and the woven fabric is introduced into the roll nip of the two rolls; and a loading method in which the woven fabric is compression bonded onto the sheet on the bottom roll that has been produced by means of calendering. There are no particular limitations on the temperature of the compression bonding rolls or on the manner in which this temperature is controlled. However, a temperature of 200°C or less is preferable in terms of decreasing the heat history of the sheet. Polyester elastomers have been used as inherently hot-melt adhesive agents, and adequate adhesive strength can be obtained on a compression-bonded surface even without the application of an adhesive agent. However, it is preferable to use polyester- or polyurethane-based hot melt adhesive agents. Although the thickness of the sheet that is obtained differs depending on its use, 20 to 5000 μ is preferred because it allows the sheet to be used in flexible containers and tents for industrial use.

[0015]

[Operation of the Invention] The polyester elastomer sheets of this invention have high precision thickness and mechanical properties, exhibit little processing degradation, and are of superior heat resistance and productivity.

[0016]

[Working Examples] The effects of this invention will now be described by means of working examples. The terms "%" and "parts" used in the working examples, unless otherwise specified, are always based on weight. The physical properties shown in the working examples and comparative examples were measured as follows. "MD" indicates the direction of the line that connects the sheet molding device and the winding device. "TD" indicates the direction perpendicular to MD. The evaluations were performed by means of the following methods.

Melting point: DSC method

Hardness (Shore D hardness): Measured in accordance with JIS K-7215.

Melt viscosity index (MFR value): Measured in accordance with ASTM D-1238 at a temperature of 200°C and a load of 2160 g.

Solution relative viscosity (η_r): Measured in 0.5% o-chlorophenol solution at 25°C.

Preparation of polyester elastomer: The polyester elastomer components constituting the sheets were a polymer obtained by means of copolymerizing poly(tetramethylene oxide) glycol with polybutylene terephthalate was used, and a polymer obtained by means of copolymerizing polycaprolactone with polybutylene terephthalate in the same manner as; and these were designated as A-1 and A-2, respectively. Table 1 shows the compositions and physical properties of A-1 and A-2. As antioxidants and processing lubricants, 0.5 parts by weight of "Irganox 1010," manufactured by Ciba-Geigy, 0.5 parts by weight of "Naugard 445," manufactured by the Uniroyal, and 0.5 parts by weight "Hi Wax 2203A," manufactured by Mitsui Petrochemical Co. were dry blended with 100 parts by weight of A-1 pellets, and the product was designated as A-1-N. 0.5 parts by weight of the blue pigment phthalocyanine (Phthalocyanine Blue B) per 100 parts by weight of polymer was dry blended with A-1-N, and the product was designated as A-1-B. Similarly, A-2 was used, antioxidants and processing lubricants were compounded, A-2-N and A-2-B were prepared with and without compounding

the same blue pigment phthalocyanine, and these substances were used as the processing raw materials. Table 2 shows the compounding compositions of A-1-N, A-1-B, A-2-N, and A-2-B.

[0017]

[Table 1]

	Quantity of polyester elastomer copolymer (wt%)	Quantity of poly(tetramethylene oxide copolymer (wt%)	Quantity of polycaprolactone copolymer (wt%)	Melting point (°C)	Shore D hardness	Solution relative viscosity	Solvent melt index (g/minute)
A-1	35	65		165	38	1.90	8
A-2	35		65	171	39	1.85	26

[0018]

[Table 2]

	Polymer (wt%)		Pigment	Additive (wt%)	Additive (wt%)	Additive (wt%)
	A-1	A-2	Phthalocyanine	Irganox 1010	Naugard 445	Hi Wax 2203A
A-1-N	100			0.5	0.5	0.5
A-1-B	100		0.5	0.5	0.5	0.5
A-2-N		100		0.5	0.5	0.5
A-2-B		100	0.5	0.5	0.5	0.5

Calender Production Test A

The processing raw materials were fed to two 28-inch rolls manufactured by Ishikawajima-Harima Heavy Industries Co., Ltd., plasticization was performed at a roll temperature of 160°C and a roll clearance of 7 mm, and a coarsely molded sheet was obtained. The material was then introduced into four 30-inch reverse L-shaped rolls, a sheet was made at a temperature of 170°C and a roll clearance of 360 mm, and the sheet was laminated onto one side of a shot fabric based on drawn polyethylene terephthalate yarn (drawn yarn of 750 denier with 20 shots/25.4 mm in both directions) at a processing speed of 40 m/minute between the four final reverse L rolls and lamination rolls combined therewith, yielding a sheet coated on one side. The uncoated side was laminated in the same way, yielding a fiber-reinforced sheet that had a sheet

thickness of 750 μm and a sheet width of 100 cm, and consisted of a polyester elastomer coated on both sides of the woven fabric.

Calender Production Test B

A fiber-reinforced sheet that had a sheet thickness of 2000 μm and consisted of a polyester elastomer coated on both sides of woven fabric was obtained at a processing speed of 40 m/minute using the same apparatus, the same setting temperature, and the same sheet width as described in Calender Production Test A.

Extrusion Lamination Production Test A

The processing raw materials were melted in a single-screw extruding machine with a diameter of 90 mm; extruded from a T-die at a cylinder-tip temperature of 290°C, a die temperature of 285°C, and an under-die resin temperature of 285°C; and extrusion-coated at a processing speed of 40 m/minute to a coating thickness of 350 μm on both sides of the woven fabric that was used in the aforementioned calender test and had been preheated in advance to 100°C, yielding a fiber-reinforced sheet that had a sheet thickness of approximately 750 μm and a width of 100 cm, and consisted of a polyester elastomer coated on both sides of the woven fabric.

Extrusion Lamination Production Test B

The same equipment and raw materials were used as described in extrusion lamination test A. The materials were extruded from a T-die at a cylinder tip temperature of 230°C, a die temperature of 225°C, and an under-die resin temperature of 225°C. As the result, a fiber-reinforced sheet that had a sheet thickness of approximately 750 μm and a width of 100 cm, and consisted of a polyester elastomer coated on both sides of the woven fabric was obtained at a processing speed of 8 m/minute.

Extrusion Lamination Production Test C

The same equipment and raw materials were used as described in extrusion lamination test A. The materials were extruded from a T-die at a cylinder tip temperature of 240°C, a die temperature of 235°C, and an under-die resin temperature of 230°C. As the result, a fiber-reinforced sheet that had a sheet thickness of approximately 2000 μm and a width of 100 cm, and consisted of a polyester elastomer coated on both sides of the woven fabric was obtained at a processing speed of 7 m/minute.

Sheet thickness, and elongation and tensile strength at break

Measurements were made in accordance with JIS K 6328. Elongation and tensile strength were measured at a drawing speed of 200 mm/minute using a 30-mm-wide rectangular strip cut from a fiber-reinforced sheet.

Peel strength

The peeling strength between a resin film layer and a fabric-bonded resin film layer was measured in accordance with JIS K 6328 at a drawing speed of 50 mm/minute using a 30-mm-wide rectangular strip cut from a fiber-reinforced sheet.

Tear strength

Measurements were made in accordance with JIS K 6328 at a drawing speed of 200 mm/minute using a 76-mm-wide rectangular strip cut from a fiber reinforced sheet, with a 75-mm notch made in its center.

Processing degradation

A resin film test specimen that had undergone the aforementioned T-shaped peel strength measurements was pulverized, and measurements were conducted to determine the aforementioned melt viscosity index (MFR value) and solution relative viscosity (η_r).

Sheet heat aging resistance

A 30-mm-wide rectangular strip punched out of a fiber-reinforced sheet was aged in a gear oven at 140°C, the tensile strength and elongation at break were measured as described above, and the time until the initial value of the tensile strength and elongation at break was reduced by half was measured.

Working Examples 1 and 2

Calender production test A as described above was performed using A-1-N and A-2-N as some of the processing materials shown in Table 2. Table 3 shows the results of the evaluations performed in Working Examples 1 and 2.

Comparative Examples 1 to 4

The known extrusion lamination production tests A and B were performed using the same processing raw materials as described in Working Example 1. The results of the evaluations performed in Comparative Examples 1 to 4 are shown in Table 3.

[0019]

[Table 3]

Example	Manufacture method	Process- ing speed (m/ minute)	Process- ing raw mat- erials	Mechanical properties of sheet						Heat R		Processing degradation	
				Sheet thickness (mm) Figures in () are standard error	Peel strength (kgf/cm)	Tearing strength (kgf)	Tensile strength (kgf/cm)		Tensile elongation (%)	Tensile strength half life (h)	Solution relative viscosity	Solvent viscosity index (g/10 minutes)	
							MD	MD					MD
Example 1	Calender A	40	A-1-N	0.75 (0.009)	5.0	34	203	206	34	35	220	1.90	11
Example 2	Calender A	40	A-2-N	0.75 (0.008)	4.6	36	207	199	36	35	365	1.80	37
Comparative Example 1	Extrusion lamination A	40	A-1-N	0.74 (0.11)	3.1	16	136	141	15	16	55	1.48	200 or over
Comparative Example 2	Extrusion lamination A	40	A-2-N	0.78 (0.13)	2.8	18	133	134	14	15	88	1.42	200 or over
Comparative Example 3	Extrusion lamination B	8	A-1-N	0.76 (0.052)	4.5	25	175	173	27	26	154	1.62	75
Comparative Example 4	Extrusion lamination B	8	A-2-N	0.75 (0.043)	4.3	23	175	179	28	30	252	1.59	88

Working Examples 3 and 4

Calender manufacture test A as described above was performed using A-1-B and A-2-B as some of the processing raw materials shown in Table 2. The results of the evaluations performed in Working Examples 3 and 4 are shown in Table 4.

Comparative Examples 5 and 6

The known extrusion lamination manufacture method B as described above was performed using the same processing materials as described in Working Examples 3 and 4. The results of the evaluations performed in Comparative Examples 5 and 6 are shown in Table 4.

Working Example 5

Calender manufacture test C was performed using A-1-N as one of the processing raw materials shown in Table 2. The results of the evaluations performed in Examples 5 are shown in Table 5.

Comparative Example 7

The known extrusion lamination manufacture test C as described above was performed using the same processing materials as described in Working Example 1. The results of the evaluations performed in Comparative Example 7 are shown in Table 5.

From the results in Table 3, it can be seen that the fiber-reinforced polyester sheets of this invention exhibited markedly better thickness precision and tear strength than those obtained by means of the known extrusion method, and that the adhesive force between the sheet and the woven fabric was also better. Because the resin film processing temperature was low, the degree of drawing and orientation of the fibers of the composite woven fabric was maintained, for which reason the tensile strength and elongation were extremely high. Moreover, because there was little processing degradation, it is clear that the products had excellent heat resistance. In spite of the fact that the processing speed in the manufacturing method of this invention is high, this method is highly suited to the manufacture of fiber-reinforced polyester sheets because these sheets can be endowed with excellent physical properties. As shown in the results of Table 4, similar results were obtained with the fiber-reinforced polyester sheets in accordance with this invention even when degradation-promoting additives were added. From the results in Table 5, it is clear that similarly good results were obtained even when a thicker resin film was used in the fiber-reinforced polyester sheets, and that excellent productivity was achieved at high processing speeds.

[0020]

[Table 4]

Example	Manufacture method	Processing speed (m/minute)	Processing raw materials	Mechanical properties of sheet						Heat R	Processing degradation	
				Sheet thickness (mm) Figures in () are standard error	Peel strength (kgf/cm)	Tearing strength (kgf)	Tensile strength (kgf/cm)		Tensile elongation (%)		Solution relative viscosity	Solvent viscosity index (g/10 minutes)
Example 3	Calender A	40	A-1-B	0.75 (0.007)	MD	MD	MD	MD	MD	MD	1.88	14
Example 4	Calender A	40	A-2-B	0.75 (0.008)	4.8	32	200	198	34	35	1.80	40
Comparative Example 5	Extrusion lamination B	8	A-1-B	0.76 (0.131)	2.5	9	79	87	9	12	1.30	200 or over
Comparative Example 6	Extrusion lamination B	8	A-2-B	0.75 (0.55)	3.0	12	80	91	11	12	1.45	200 or over

[0021]

[Table 5]

Example	Manufacture method	Processing speed (m/Minute)	Processing raw materials	Mechanical properties of sheet						Heat R	Processing degradation	
				Sheet thickness (mm) Figures in () are standard error	Peel strength (kgf/cm)	Tearing strength (kgf)	Tensile strength (kgf/cm)		Tensile elongation (%)		Solution relative viscosity	Solvent viscosity index (g/10 minutes)
Example 5	Calender B	40	A-1-N	2.00 (0.009)	4.8	78	498	505	42	44	1.90	11
Example 7	Extrusion lamination C	7	A-1-N	2.00 (0.124)	3.3	43	380	363	31	33	1.55	120

[0022]

[Effect of the Invention] As a result of the fact that calendering is used in the manufacture of the fiber-reinforced polyester elastomer sheets in accordance with this invention, not only are thickness precision and mechanical properties markedly superior to those of sheets obtained by means of the known extrusion method, but there is also extremely little processing degradation, and the physical properties of the sheets are not affected by the processing speed. Consequently, whereas fiber-reinforced polyester elastomer sheets conventionally manufactured by means of extrusion molding are essentially limited to special uses due to their high cost (which is unrelated to high performance), the fiber-reinforced polyester elastomer sheets based on this invention have stable physical properties, are inexpensive, and can therefore be widely used in the general applications generally reserved for polyvinyl chlorides, i.e., as primary fabrics for flexible containers and large products such as tents for industrial use.

(Continued from front page)

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